Journal of Animal and Veterinary Advances 9 (20): 2608-2612, 2010
ISSN: 1680-5593

The Influence of Different Levels of Brewers Spent Grain and Enzyme on Performance and Digesta Viscosity of Broiler Chicks

S.J. Hussaini, H. Nassiri Moghaddam and H. Kermanshahi
Department of Animal Science, Excellence Center for Animal Science,
Ferdowsi University of Mashhad, P.O. Box 91775-1163, Mashhad, Iran

Abstract: An experiment was conducted to study the influence of different levels of Brewers Spent Grain (BSG) and Enzyme Supplementation (ES) in the diet on the productive performance and digesta viscosity of broilers from 7-42 day of age. Six treatments were arranged factorially with 3 levels of BSG (none, 7.5 and 15%), unsupplemented and supplemented with 0.05% enzyme. Treatments were formulated with the same AME_n and protein. Each treatment was replicated four times (consist of 12 chicks per replicate). During the experimental period daily weight gain, feed conversion and feed intake evaluated. At 21 and 42 days one bird from each replicate killed for measuring digesta viscosity.

Key words: Brewers spent grain, broilers, enzyme supplementation, performance, viscosity, unsupplemented

INTRODUCTION

Brewery Waste (BW) is a by product of beer making and contains 21-29% crude protein on DM basis (Su and Heng-Chun, 1995; Westendorf and Wohlt, 2002). BW consists largely of structural carbohydrates and the protein remaining when barely is malted and mashed to release sugars for brewing. It is a concentrated source of digestible fiber, with good amino acid, B-vitamin and phosphorus contents but is low in other minerals. The results show that traditionally BW has only been used for feeding ruminants, due to the high level of fiber (Cromwell *et al*., 1993; Shurson, 2003). However, research has shown that BW can be successfully fed to poultry (Parsons *et al*., 1983; Noll *et al*., 2001). Brewers Spent Grain (BSG), the main by-product of the brewing industry, is rich in proteins and dietary fiber (Mussatto *et al*., 2006). The composition of BSG varies with barley variety, time of harvest, adjuncts added and brewing technology (Santos *et al*., 2003). During malting, barley proteins are in part degraded to amino acids and small peptides by a range of proteolytic enzymes (Baxter, 1981; Enari and Sopanen, 1986; Jones, 2005). Nutritional evaluations of BSG have been reported by Celus *et al*. (2006), who stated that the typical crude protein content (DM basis) of BSG was 26%. In practical diet formulation of broilers inclusion rates up to 20% of BW did not depress gains or feed conversion during early growth (0-4 and 4-8 weeks) and rates of up to 30% were not observed to decrease performance in broilers from 8-12 weeks old (FAO, 2005). Celus *et al*. (2006) reported that β-glucan content decreased with malting but amount of arabinoxylans increased extremely which are known to have an anti-nutritive effect on broilers and to decrease energy and nitrogen availability. Valverde (1994) found that BSG is rich in cellulose (17%) and non-cellulosic polysaccharides (mainly arabinoxylans) (39%). Soluble Nonstarch Polysaccharides (NSP) present in viscous grains increase digesta viscosity which interferes with the activity of intestinal enzymes in the gastrointestinal tract. As a consequence, feeding barley increases the incidence of sticky droppings, reduces the extent of digestion and absorption of nutrients and impairs broiler performance (Annison and Choct, 1991). Increases in intestinal viscosity reduce macronutrient digestibility, digestive enzyme activities (Smits *et al*., 1997), ability of the gut to vigorously mix intestinal contents and the rate of passage of digesta through the intestine (Salih *et al*., 1991). Deleterious effects associated with increased intestinal viscosity are more pronounced in younger birds (Almirall *et al*., 1995). Enzymes reduce viscosity and improve nutrient digestibility and feed intake (Lazaro *et al*., 2003a, b). Therefore, the objectives of this study were to examine the influence of ES on the productive performance and intestinal viscosity of broilers fed different levels of BSG.

MATERIALS AND METHODS

Birds, diets and enzyme: About 1 day old male (Ross 308) broiler chicks were obtained from a local commercial hatchery. The birds were fed commercial chick starter diet

Corresponding Author: Sayyed Javad Hussaini, Department of Animal Science, Faculty of Agriculture, Ferdowsi University of Mashhad, Mashhad, Iran

Table 1: Composition and nutritive value of the experimental diets[1]

	7-21 days			21-42 days		
Ingredients (%, as fed)	Diet 1(Control)	Diet 2	Diet 3	Diet 1(Control)	Diet 2	Diet 3
Corn	60.70	54.75	50.50	65.00	64.00	58.00
Soybean meal	34.00	30.50	25.20	2.60	-	-
Brewers dried grain	-	7.50	15.00	28.40	24.00	20.90
Wheat bran	-	-	-	-	7.50	15.00
Fish meal	1.00	2.00	3.40	-	1.00	1.00
Vegetable oil	0.70	2.00	3.00	0.50	0.50	2.00
Limestone	1.00	0.90	0.70	1.50	1.20	1.00
Bone meal	1.50	1.30	1.20	1.10	1.00	1.20
Salt	0.35	0.30	0.30	0.30	0.20	0.20
DL-Methionine	0.25	0.25	0.20	0.20	0.10	0.10
L-Lysine	-	-	-	0.10	-	0.10
Vitamin-mineral premix[1]	0.50	0.50	0.50	0.50	0.50	0.50
Estimated analysis						
ME (kcal/kg)	2950.10	2951.40	2950.98	2950.29	2950.20	2949.90
Crude protein (%)	21.08	21.31	21.10	18.88	18.61	18.53
Crude fiber (%)	3.90	4.70	4.41	2.80	3.94	4.39
Lysine (%)	1.16	1.16	1.14	1.00	0.94	0.98
Methionine (%)	0.58	0.61	0.59	0.49	0.43	0.44
Calcium (%)	0.94	0.92	0.92	0.83	0.84	0.85
Available phosphorus (%)	0.43	0.42	0.42	0.34	0.33	0.34

[1]Supplied kg^{-1} of diet: selenium, 0.15 mg; iodine, 2 mg; cobalt, 0.2 mg; copper, 6 mg; iron, 30 mg; zinc, 50 mg; manganese, 80 mg; retinyl acetate, 7,500 IU; cholecalciferol, 1,500 IU; dl-tocopheryl acetate, 7.5 IU; riboflavin, 5.3 mg; pantothenic acid, 8 mg; pyridoxine, 1.8 mg; folic acid, 0.5 mg; menadione sodium bisulfite, 2 mg; vitamin B12, 12.5 mg; niacin, 24 mg; choline, 350 mg, ES have been added to each diet as supplement with two ration of 0.0 and 0.05%

(21% CP) for a 7 days pre-experimental period. At 7 day of age, 288 of the birds were selected according to body weight (145±2 g) and randomly distributed among the 6 treatments, using 12 birds per pen and 4 replicate pens per treatment. The experiment was of 6 weeks (7-42) duration. All chicks received an isocaloric and isonitrogenous starter feed (21% CP and 2950 kcal ME kg^{-1}) during the 7-21 day followed by a grower feed (Table 1). All diets were formulated to meet or exceed requirements by the National Research Council (NRC, 1994) for broilers. The 3×2 factorial arrangement included three levels of the BSG (none, 7.5 and 15%), unsupplemented and supplemented with 0.05% enzyme included in experimental diets. BSG was obtained from commercial malting company. The commercial enzyme preparation (Endofit WNC, Biform Canada) used in this study was contained 440 IU of β-glucanase and 1200 IU of arabinoxylanase per gram. The composition of the experimental diets is shown in Table 1.The birds had free access to water and feed and were provided with continuous light. Body weight and feed intake was monitored weekly with pen as the experimental unit. Mean weight gain, feed intake and feed-to-gain ratio were used to determine the growth performance.

Viscosity: At 21 and 42 day of age, one chick per replicate cage were randomly selected and killed by cervical dislocation. The jejunum, defined as the region from the pancreas tail to the Meckel's diverticulum was dissected and the content collected as described by Bedford *et al.* (1991). The viscosity (centipoise, cP) of a 0.5 mL aliquot obtained from the supernatant solution was determined by using a Brookfield digital viscometer.

Statistical analysis: Statistical analysis of results was performed using the GLM procedure of the SAS software (SAS, 1990). Productive performance data were analyzed as a randomized complete design and main effects (level of BSG and enzyme) and their interactions were studied. All differences were considered significant at $p<0.05$. According to the following general model:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk}$$

Where:

Y_{ijk} = The observed dependent variable
μ = The overall mean
α_i = The effect of BSG
β_j = The effect of enzyme addition
$(\alpha\beta)_{ij}$ = The interaction between BSG and enzyme addition
ε_{ijk} = The random error

RESULTS AND DISCUSSION

Performance: No significant differences were observed in feed intake of birds by feeding BSG as compared to control grope. Enzymes significantly improved feed intake at 14-21 day (63.4 vs. 65.4 g day^{-1}) ($p<0.05$) (Table 2). Exogenous enzymes have been shown to dramatically improve the use of certain feedstuffs such as barley, wheat, rye and oats, especially in poultry (Marquardt *et al.*, 1994; Zhang *et al.*, 1997). The study showed improved growth performance when ES was included. No significant differences were noted for bird feed intake in grower periods by ES (21-42 day).

Table 2: Daily feed intake (g day^{-1}) of broilers fed different levels of BSG[1] (%) diets with or without ES[2] (%)

Analysis	7-14	14-21	21-28	28-35	35-42	7-21	21-42	7-42
Main effect								
BSG								
0	43.25	64.60	131.200	123.500	213.100	53.900	156.500	117.700
7.5	43.28	64.50	132.800	128.400	216.900	53.900	159.900	120.100
15	42.55	64.00	138.200	129.400	221.200	53.290	162.900	121.200
SEM[3]	0.94	0.75	3.570	1.760	5.680	0.770	3.000	2.150
ES								
0	43.50	63.40^{b}	131.500	126.000	214.000	52.900	157.600	118.100
0.05	42.50	65.40^{a}	136.500	127.000	219.000	54.500	161.900	121.300
SEM	0.77	0.61	2.910	1.430	4.600	0.630	2.400	1.750
Probabilities								
BSG	0.840	0.860	0.350	0.063	0.620	0.810	0.510	0.260
ES	0.430	0.008	0.190	0.780	0.960	0.052	0.320	0.420
BSG×ES	0.110	0.130	0.130	0.400	0.640	0.440	0.900	0.870

[1]Brewers spent grain; [2] Enzyme supplementation (Endofid W GNC, Biform Canada); [3]There were four replicate cages per treatment and the number of birds per cage was 12 from 7-21 day and from 21-45 days $^{a-b}$Means within the same column with different superscripts differ significantly ($p<0.05$)

Table 3: Weight gain (g/d) of broilers fed different levels of BSG[1] (%) diets with or without ES[2] (%)

Analusis	7-14	14-21	21- 28	28- 35	35- 42	7-21	21-42	7-42
Main effect								
BSG								
0	24.630	43.900^{a}	59.800	64.400	109.3000^{a}	34.200^{a}	78.190	62.400^{a}
7.5	23.660	43.600^{a}	55.300	63.400	94.3300^{b}	33.600^{a}	70.200	58.200^{b}
15	22.090	40.200^{b}	57.300	63.600	113.0000^{a}	31.400^{b}	78.000	60.900^{a}
SEM[3]	0.720	0.800	1.910	2.210	4.8600	0.590	1.850	1.210
ES								
0	22.610	41.250^{b}	56.840	62.840	104.8000	32.100^{b}	75.400	59.800
0.05	24.220	43.980^{a}	58.180	64.750	106.5000	34.100^{a}	76.200	61.230
SEM	0.590	0.650	1.560	1.800	3.9000	0.480	1.510	0.990
Probability								
BSG	0.110	0.010	0.470	0.900	0.0300	0.004	0.070	0.020
ES	0.080	0.010	0.530	0.530	0.8100	0.003	0.380	0.650
BSG×ES	0.240	0.910	0.340	0.060	0.7300	0.380	0.770	0.620

[1]Brewers spent grain[2], Enzyme supplementation (Endofid W GNC, Biform Canada), [3]There were four replicate cages per treatment and the number of birds per cage was 12 from 7-21 days and 11 from 21-45 days. $^{a-b}$Means within the same column with different superscripts differ significantly ($p<0.05$)

There were no significant treatment effects on feed consumption through the end of the experiment. Treatment effects on BW in the end of the starter period by enzymes supplementation was due to increase in feed consumption ($p<0.05$). Table 3 is a results of body weight gain determined at 14, 21, 28, 35 and 42 day of age. There were no significant treatment effects observed on body weight gain by ES on day 42 but the enzyme treatments improved body weight gain at 21 day of age. Table 4 feeding 0.05% ES during the starter period may be more beneficial than thereafter, as observed in the trial. It is possible that at early ages the beneficial effects of ES on nutrient retention overwhelmed the negative effect of the higher soluble NSP content and viscosity in the gut. The improved performance observed at early ages with ES are consistent with previous research with young chicks fed barley diets (Vranjes and Wenk, 1995). Villus height and surface area increased with ES and improvements in nutrient retention and productive performance detected (Viveros *et al*., 1994). Bedford *et al.* (1991) reported that viscosities were significantly correlated only with carbohydrate fractions that existed as complexes >500,000 Da. It's seemed that high concentration of arabinoxylans of BSG degraded to small units <500,000 Da in malting process that resulted to no increase of intestinal viscosity or reduced performance.

Intestinal viscosity: Intestinal viscosity was not affected by enzyme supplementation but tended to decrease with age an observation consistent with previous results (Petersen *et al*., 1999). Water to feed intake ratio increases with age and as a consequence, DM and viscosity of the intestinal content is reduced. Moreover, Petersen *et al.* (1999) speculated that the decrease in viscosity with age observed in broilers may be a consequence of acclimatization to diet, including an alteration in the microflora. feeding 15% BSG decreased Intestinal viscosity ($p = 0.05$) (Table 5). The major endosperm cell wall NSP are the β-glucans in barley (Cambell and Bedford, 1992) But β-glucan content decreased with malting but amount of arabinoxylan increased extremely (Celus *et al*., 2006). In the current study, the soluble NSP of BSG had no detectable viscosity effects. The results of these studies indicate no negative effect of feeding 15%

Table 4: FCR of broilers fed different levels of BSG[1] (%) diets with or without ES[2] (%)

Analysis		7-14	14-21	21-28	28-35	35-42	7-21	21-42	7-42
Main effect									
BSG									
0		1. 760^{b}	1.470^{b}	2.100^{b}	1.920	1.950^{b}	1.570^{b}	2.000^{c}	1.8800^{b}
7.5		1.830^{ab}	1.480^{b}	2.400^{a}	2.070	2.320^{a}	1.600^{b}	2.250^{a}	2.0000^{a}
15		1.930^{a}	1.600^{b}	2.410^{a}	2.040	1.970^{a}	1.700^{a}	2.090^{b}	1.9000^{b}
SEM		0.059	0.020	0.050	0.090	0.070	0.026	0.035	0.0250
ES									
0		1.880	1.540	2.320	2.050	2.040	1.650	2.100	1.9700
0.05		1.800	1.490	2.350	1.970	2.120	1.600	2.300	1.9800
SEM[3]		0.040	0.022	0.046	0.077	0.060	0.021	0.020	0.0200
BSG×ES									
BSG	ES								
0	0.00								1.8400^{c}
	0.05								1.9200^{bc}
7.5	0.00								2.0900^{a}
	0.05								2.0300^{ab}
15	0.00								1.9800^{abc}
	0.05								1.9900^{abc}
SEM									0.0360
Probabilities									
BSG		0.0400	0.0020	0.0200	0.2800	0.0010	0.0020	0.0003	0.0002
ES		0.0700	0.1500	0.4300	0.9400	0.3300	0.1100	0.4100	0.2800
BSG×ES		0.4500	0.1300	0.9600	0.1083	0.4500	0.2200	0.0690	0.0490

[1]Brewers spent grain; [2]Enzyme supplementation (Endofid W GNC, Biform Canada); [3]There were four replicate cages per treatment and the number of birds per cage was 12 from 7-21 days and from 21-45 days; [a-b-c]Means within the same column with different superscripts differ significantly ($p<0.05$)

Table 5: Viscosity of intestinal content of broilers

	BSG[1]				ES[2]			Probabilities		
								BSG	ES	ES×BSG
Viscosity	0	7.5	15	SEM[3]	0	0.05%	SEM	p-value		
Age										
21 days	1.10^{a}	1.14^{a}	0.84^{b}	0.10	0.99	0.99	0.08	0.02	0.99	0.27
42 days	0.54	0.69	0.62	0.15	0.63	0.60	0.12	0.77	0.88	0.95

[1]Brewers spent grain; [2]Enzyme supplementation (Endofid W GNC, Biform Canada); [3 3]There were four replicate cages per treatment and the number of birds per cage was 12 from 7-21 day and 11 from; [a,b]Values within a rows with unlike superscripts differ significantly ($p<0.05$)

BSG throughout the broiler growth period. The results of the present experiment clearly indicate that BSG may be used up to 7.5% of the diets without having adverse effects on broilers performance. The use of enzymes in diets for broilers based on BSG is recommended at early ages. But more studies are needed to evaluate the beneficial effects of enzymes on broiler productivity.

CONCLUSION

The results indicated a significant reduction in weight gain, feed intake and increase in feed conversion in broilers by feeding 15% BSG at during the starter period in comparison of control group ($p<0.05$). ES improved body weight, feed intake and daily weight gain in starter period ($p<0.05$). Digesta viscosity in broilers decreased with feeding 15% BSG in starter period ($p<0.05$). It was concluded that broiler performance is improved by ES at early ages. Also, BSG may be used up to 7.5 and 15% of the diets of broilers at starter and grower period, respectively.

REFERENCES

Almirall, M., M. Francesch, A.M.P. Venderell, J. Brufau and E.E. Garcia, 1995. The differences in intestinal viscosity produced by barley and β-glucanase alter digesta enzyme activities and ileal nutrient digestibilities more in broiler chicks than in cocks. J. Nutr., 125: 947-955.

Annison, G. and M. Choct, 1991. Anti-nutritive activities of cereals non-starch polysaccharides in broiler diets and strategies minimizing their effects. Worlds Poult. Sci. J., 47: 232-242.

Baxter, E.D., 1981. Hordein in barley and malt-A review. J. Inst. Brewing, 87: 173-176.

Bedford, M.R., H.L. Classen and G.L. Campbell, 1991. The effect of pelleting, salt and pentosanase on the viscosity of intestinal contents and the performance of broilers fed rye. Poult. Sci., 70: 1571-1577.

Cambell, G.L. and M.R. Bedford, 1992. Enzyme applications for monogastric feed: A review. Can. J. Anim. Sci., 72: 449-466.

Celus, I., B. Kristof and A.D. Jan, 2006. The effects of malting and mashing on barley protein extractability. J. Cereal Sci., 44: 203-211.

Cromwell, G.L., K.L. Herkelman and T.S. Stahly, 1993. Physical, chemical and nutritional characteristics of distillers dried grains with solubles for chicks and pigs. J. Anim. Sci., 71: 679-686.

Enari, T.M. and T. Sopanen, 1986. Mobilisation of endospermal reserves during the germination of barley centenary review. J. Inst. Brewing, 92: 25-31.

FAO, 2005. Brewer's grains, wet brewer's grains, dried brewers grains, brewers spent grain, brewers dried yeast. Anim. Feed Resour. Inform. Syst. http://www.fao.org/ag/aga/agap/frg/afris/Data/468.HTM.

Jones, B.L., 2005. Endoproteases of barley and malt. J. Cereal Sci., 42: 139-156.

Lazaro, R., M. Garcia, M.J. Aranibar and G.G. Mateos, 2003a. Effect of enzyme addition to wheat, barley and rye based diets on nutrient digestibility and performance of laying hens. Br. Poult. Sci., 44: 256-265.

Lazaro, R., M. Garcia, P. Medel and G.G. Mateos, 2003b. Influence of enzymes on performance and digestive parameters of broilers fed rye-based diets. Poult. Sci., 82: 132-140.

Marquardt, R.R., D. Boros, W. Guenter and G. Crow, 1994. The nutritive value of barley, rye, wheat and corn for young chicks as affected by use of a *Trichoderma reesei* enzyme preparation. Anim. Feed Sci. Technol., 45: 363-378.

Mussatto, S.I., G. Dragone and I.C. Roberto, 2006. Brewers spent grain: Generation, characteristics and potential application. J. Cereal Sci., 43: 1-14.

NRC, 1994. Nutrient Requirements of Poultry. 9th Edn., National Academy Press, Washington, DC., USA., ISBN-13: 978-0-309-04892-7.

Noll, S., V. Stangeland, G. Speers and J. Brannon, 2001. Distillers grains in poultry diets. Proceedings of the 62nd Minnesota Nutrition Conference and Minnesota Corn Growers Association Technical Symposium, Bloomington, MN.

Parsons, C.M., D.H. Baker and J.M. Harter-Dennis, 1983. Distillers dried grains with solubles as a protein source for the chick. Poultry Sci., 62: 2445-2451.

Petersen, S.T., J. Wiseman and M.R. Bedford, 1999. Effects of age and diet on the viscosity of intestinal contents in broiler chicks. Br. Poult. Sci., 40: 364-370.

SAS, 1990. SAS/STAT User's Guide: Statistics. 4th Edn., Vol. 6, SAS Institute Inc., Cary, NC.

Salih, M.E., H.L. Classen and G.L. Campbell, 1991. Response of chickens fed on hull-less barley to dietary B-glucanase at different ages. Anim. Feed Sci. Technol., 33: 139-149.

Santos, M., J.J. Jimenez, B. Bartolome, C. Gomez-Cordoves and M.J. del Nozal, 2003. Variability of brewers spent grain within a brewery. Food Chemistry, 80: 17-21.

Shurson, G.C., 2003. Distiller's Dried Grains with Solubles (DDGS) suited for swine may help ileitis resistance. Feedstuffs, 26: 11-13.

Smits, C.H.N., A. Veldman, M.W.A. Verstegen and A.C. Beynen, 1997. Dietary carboxymethylcellulose with high instead of low viscosity reduces macronutrient digestion in broiler chickens. J. Nutr., 127: 483-487.

Su, A.K. and S. Heng-Chun, 1995. Utilization of agricultural by-products in Taiwan. http://www.agnet.org/library/eb/422/.

Valverde, P., 1994. Bagazo y su futuro. Cerveza y Malta, 122: 7-26.

Vivero, A., A. Brenes, M. Pizarro and M. Gastano, 1994. Effect of enzyme supplementation of a diet based on barley and autoclave treatment, on apparent digestibility, growth performance and gut morphology of broilers. Anim. Feed Sci. Technol., 48: 237-251.

Vranjes, M.V. and C. Wenk, 1995. The influence of extruded vs. untreated barley in the feed, with and without dietary enzyme supplement on broiler performance. Anim. Feed Sci. Technol., 54: 21-32.

Westendorf, M.L. and J.E. Wohlt, 2002. Brewing by-products: Their use as animal feeds. Vet. Clin. Food Anim. Pract., 18: 233-252.

Zhang, Z., R.R. Marquardt, W. Guenter and Z. Han, 1997. Effect of different enzyme preparations supplemented in a rye-based diet on the performance of young broilers and the viscosity of digesta and cloacal excreta. Chin. J. Anim. Sci., 34: 3-6.